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The Dairy Focus

Capital Region • Penn State Cooperative Extension Dairy Program

Managing Corn Silage

Silage Additives

Limin Kung, Jr., Professor of Dairy Nutrition, Univ. of Delaware

Poor silage fermentation can lead to extensive nutrient losses and lowered production that both equate to reduced farm income. The use of a silage additive is one possible method to improve these fermentations.

Most chemical based products are aimed at improving the shelf life (aerobic stability) of silages by inhibiting the growth of yeasts and molds. Buffered propionic acid is the major active ingredient but many of these products also contain other antifungal compounds such as acetic acid, benzoic acid or potassium sorbate. Because of the high cost for these chemicals, recommended application rates range from 1 to 4 lb/ton of forage. We find the most consistent effects with the higher levels of application.

Bacterial inoculants are also commonly added to silages but they have historically been added to improve fermentation, not shelf life. They are primarily based on bacteria that quickly produce copious amounts of lactic acid. Some of the more common bacteria in this class of microbes are *Lactobacillus plantarum* and various *Pediococcus* species. The fast drop in pH caused by these microbes helps to improve nutrient recovery in the silage but it is a misconception that low pH alone will improve shelf life by inhibiting the growth of yeasts and molds. For improving the shelf life of forages, *Propionibacteria* have been suggested to be beneficial because they can produce propionic and acetic acids that can keep yeasts and molds in check. However, there is limited data that supports this claim. Recently, a newer bacterium, *Lactobacillus buchneri*, has seen much success in improving the shelf life of silages in published research studies and in the field, because it converts a moderate amount of lactic acid to acetic acid. Several inoculants now contain fast growing lactic acid bacteria that produce lactic acid and *L. buchneri,* and are often referred to as "combination products." Products with traditional lactic acid bacteria should be supplying a minimum of 100,000 colony forming units (cfu) of these bacteria per gram of forage. Of the two products containing *L. buchneri,* one supplies 100,000 while the other supplies 400,000 cfu/g of forage because of strain differences. Specifically for high moisture corn, one *L. buchneri* product supplies 600,000 cfu/g of forage.

Choosing the best additive is a difficult task! Read this article for some guidelines.

Enzymes are often a part of many silage additives.

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Corn Silage and Animal Health

Dr. Robert Van Saun, Ext.Veterinarian, Penn State University

Corn silage is a foundation forage for dairy rations in Pennsylvania and as such, contributes greatly to the success or failure of your cow's productivity. How do you determine if your corn silage is limiting animal health and productivity on your farm? There are a number of simple silo-side tests one can perform to evaluate corn silage as a potential source of animal health problems.

First, look, feel and smell the silage. Abnormally fermented corn silage may have a brighter yellow color and a vinegar or alcohol smell. Yeast overgrowth is often the culprit. Poor packing efficiency, larger particle size and high dry matter all contribute to improper fermentation. High sugar content, like with immature corn silage, can also contribute to yeast problems. Does the silage feel warm to the touch? This is another indicator of continued microbial fermentation. You can measure the silage's temperature with a compost thermometer. If temperatures are above 90°F, this indicates microbial heating from secondary or excessive fermentation. Temperatures above 110°F are of great concern as the silage can undergo a reaction binding proteins and sugars making them unavailable for digestion by the cow, thus reducing forage quality.

A key indicator for evaluating silage quality is pH. Corn silage should achieve a pH of 3.5 to 4.2 units within 7 days of ensiling. Wetter silage should have lower values. The low pH pickles the feed, preventing further microbial fermentation and nutrient losses. Abnormal fermentation and yeast overgrowth will generally alter corn silage pH, but not always. Altered pH due to abnormal microbial growth, especially yeasts, reduces corn silage palatability and intake. This could contribute to ketosis and displaced abomasum problems in fresh cows. Risk of harmful mold growth and production of mycotoxins greatly increases in these poorly fermented corn silages. Coliform bacteria, primarily Salmonella, can survive in improperly fermented corn silage and this risk greatly increases with recent manure applications within 2 weeks of harvesting. Yeast and mold counts, mycotoxin screens and fermentation profiles are additional diagnostic tests to evaluate corn silage fermentation adequacy and its impact on animal health.

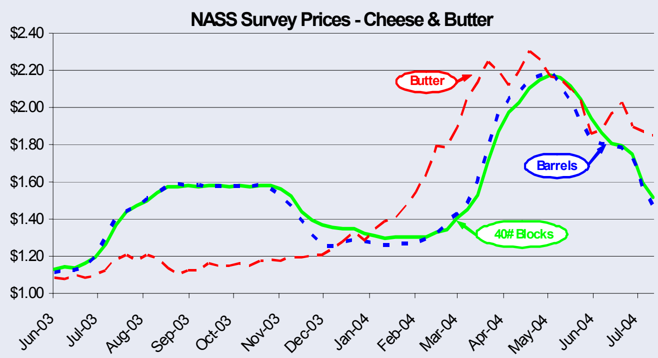
Animal health problems can also occur with normally fermented corn silage and not just from microbial sources. Nutrient composition and physical properties of corn silage need to be evaluated. Newer corn silage varieties are increasing fiber digestibility and starch content. Both will contribute to increasing milk production, but can also result in animal health problems.

Starch content increases corn silage energy content and potential to make milk. High starch intake will decrease rumen pH and induce a whole spectrum of potential problems from indigestion to acidosis. In addition to measuring total starch content or nonstructural carbohydrate content, one needs to consider moisture, particle size and processing. High moisture, reduced particle size and processing will increase starch availability and risk of associated animal health problems. Varying degrees of ruminal acidosis can result in reduced milk fat, cyclic feeding and milk production patterns, variable manure consistency up to acidosis, laminitis and displaced abomasum.

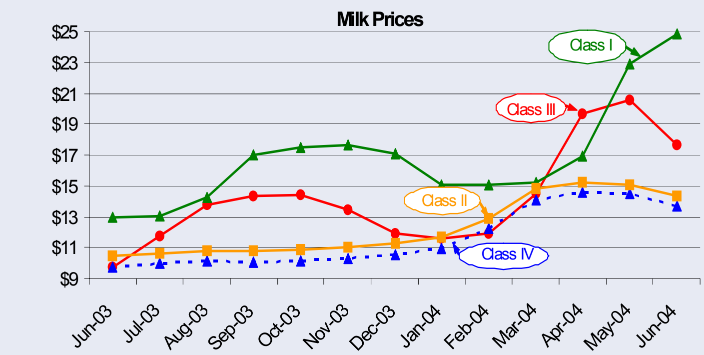
Corn silage with high fiber content and low fiber digestibility can result in low milk production and dry matter intake. Often high fiber or more mature corn silage will have larger particle size, which can contribute to poor fermentation as described. If fiber content is low or it is of highly digestible, then particle size is often reduced and effective fiber content of the diet may be insufficient. Indigestion, acidosis, displaced abomasum and other rumen problems can result.

Corn silage will remain a mainstay of Pennsylvania dairy rations. Improved diagnostic testing can help provide better insight into the potential role of corn silage in animal health problems.

"Milk Market Watch"



Source: USDA - National Agricultural Statistics Service http://usda.mannlib.cornell.edu/reports/nassr/price/dairy/



Source: USDA Dairy Program, Northeast Milk Marketing Order, http://www.fmmone.com/

Using the Penn State Particle Separator for Corn Silage

Dr. Jud Heinrichs, Professor of Dairy Science, Penn State University

Evaluating a ration to determine if it will meet the nutrient requirements of high producing dairy cows requires detailed understanding of the chemical components of feeds such as protein, minerals, and fiber as well as some of the physical characteristics of the feeds being fed, including particle size. All of these parameters can be used in ration formulation for dairy cows and all of these will impact rumen function in high producing cows.

Understanding of the importance of forage particle size in dairy cow nutrition has improved greatly in the past several years. It has become more important to understand particle size of the ration as we strive to formulate diets that will allow dairy cows to reach toward their genetic capability in terms of milk production. As we raise milk production we raise the total nutrient needs of the animal. This makes it more important that we strive to maintain the cow at peak levels of intake while keeping the rumen environment in a stable and consistent state.

Since its introduction eight years ago, the Penn State Forage and TMR Particle Separator has become an internationally recognized tool for evaluating forage and TMR particle size on-farm and in research trials. Through research, we now have recommended particle size ranges for individual forages, and TMR or total ration particle size. The main goal of analyzing total ration particle size is to measure the distribution of feed and forage particles that the cow actually consumes throughout the day. This means measuring samples fresh from the feed bunk before the cows eat or sort the feed, as well as measuring what the cow consumes throughout the day.

Over the past four years, research at Penn State has centered upon improving the Particle Separator and the interpretation of TMR particle size information. Originally the Penn State Particle Separator consisted of two sieves and a bottom pan. Openings in the two sieves measured 0.75 and 0.31 inches. While this design worked well for forages, it was limited in its use for TMRs Total mixed rations typically contain 40 to 60 percent concentrate and much of this passes through the smallest 0.31-inch sieve, ending up in the bottom pan along with finer forage particles. As a result, a great deal of the highly fermentable components of the diet was less accounted for by the original Penn Sate Particle Separator. Measurement of the smaller particles is important because we know that the finer the feed particles are, the faster they can be degraded in the rumen. We also know some of these very fine particles can pass out of the rumen and escape rumen fermentation completely. Through research and field application we now understand that a difference in grain processing also affects digestibility and utilization by the animal. Often this grain processing is related to modifying grain particle size. Therefore the Penn State Particle Separator needs to account for all feed particle sizes, including grains, as much as possible.

Based on new research since development of the original model, we have added a new component to the Penn State Particle Separator. This is a new sieve (screen) to add to the existing set, with openings 0.05 inch in diameter. This new sieve allows us to separate the fine fraction of most TMR samples into two parts, which provides us with a measurement of the very fine fraction (less than 0.05 inch) of the TMR. Research shows that this fraction is digested very rapidly or passes out of the rumen rapidly and escapes rumen fermentation completely. Our investigation of these new fractions has enabled us to refine forage and TMR particle size recommendations for today's high producing dairy cows. Much of the Penn State research with the particle separator was done with cows in early lactation producing in excess of 100 lbs of milk daily. We can now better measure the very fine fraction of the TMR particles as well as the larger particles. Essentially this new screen allows us to look at the total ration particle size distribution, not just the longer or forage fraction that relates to rumination or cud chewing, but the grain and finer components that affect rumen acid production and pH.

Corn Silage Particle Size Recommendations

During harvest you can obviously have a great impact on forage particle size and it is an ideal time to use a separator to measure the chop length. Keep in mind that the machine settings are an approximation of the resulting particle size. Many factors affect the end result on forage particle size, with the machine settings being only one of those. The chop length of corn silage must balance good packing and fermentation with allowance for good rumen function when the cows are fed the forage. A prime consideration with corn silage is to have the material well packed to achieve a good fermentation.

Our corn silage particle size recommendations are for the majority of the crop to fall within the two middle screens of the Penn State Particle Separator. Three to 8 percent maximum can be on the top pan.

Particle Separator, continued on page 4

The Penn State Particle Separator on the World Wide Web

New tools are now available to evaluate forage and TMR particle size distribution and can be accessed via the world wide web. Users of the Penn State Particle Separator can log on to www.das.psu.edu/dcn/catforg/particle/ to download information related to the particle separator.

Silage Additives, Continued from page 1

These enzymes are primarily fiber digesting. Theoretically, they should help to improve fermentation by increasing the amount of sugars for lactic acid bacteria to grow on and produce lactic acid. Claims that enzymes are increasing fiber digestibility are generally not supported by research data.

Choosing the best additive and product is a difficult task but here are some guidelines that I think may help you in the decision making process. First, ask the company for "independent published research" that supports their claims; the more, the better. Second, buying an additive based on cost alone is an unsound practice. Third, be sure that the company selling the additive has a strong technical staff that is willing to help you with forage management practices. Generally, grasses and alfalfa benefit more by the addition of a good fast growing lactic acid bacterium. In contrast, either a chemical preservative or an inoculant containing *L. buchneri* generally helps high moisture corn and corn silage more.

Application of a silage additive is best made at the chopper if the forage is being packed in a bunk, drive over pile or pit because of better distribution of the product. If forage is packed into a bag or upright silo, application can also be done efficiently at the blower or bagger. When using a bacterial inoculant, take care in handling the organisms. Do not leave bags or bottles partially open or in hot locations. Unused materials in spray tanks are usually good for about 36-48 h.

Silage additives are useful tools that can improve the fermentation process. Remember to calibrate all applicators for proper dosing. Also, follow good harvest and silo management practices. For example, harvest at optimum maturity, wilt as needed, chop to correct particle size for effective fiber, fill fast but pack tightly, seal immediately and keep the air out of the silo mass during storage and feeding.

Photo Credit: Photos on page one were downloaded from www.vigortone.com/SilageInoculantAplicator.htm.

Bunker Silo Meetings with Dr. Brian Holmes:

Dr. Brian Holmes is an agricultural engineer from the University of Wisconsin. Brian has worked for many years on bunker silo issues. He has helped to pioneer bunker silo packing recommendations. In addition Brian has investigated the economics of using facers to remove silage and how to maximize silage bags for efficiencies. On August 10 and 11 Dr. Holmes will be presenting his recommendations at two morning seminars in Lancaster and Franklin Counties.

On Tuesday August 10 from 9:00 am until 12:00 noon a seminar will be held at the Lancaster DHIA office, 1592 Old Line Road, Manheim. On Wednesday August 11, again from 9:00 am until noon the program will be presented at the Lighthouse Restaurant, Rt. 11, north of Chambersburg. Topics include: What Have We Learned about Silage Densities; Achieving Optimum Silage Densities; Results from the 2004 Capital Region Bunker Study; and Bunker Silo Facers – Are they worth the investment. Brian will also use his Excel programs to demonstrate silage packing strategies.

Cost to attend either of these workshops is $10.00. Registration is preferred prior to August 5, but walk-in participants will also be welcomed. To register contact the Dauphin County Extension office to request a registration form. Call 717-921-8803 for a form. Forms are also available from the Lancaster (717-394-6851) and Franklin County (727-263-9226) Extension offices.

Particle Separator, Continued from page 3

This is one of the two fractions that will allow for particles to be ruminated; however these particles are also easy for a cow to sort. We need to strive to limit sorting and therefore need to limit the amount in this top screen. This means 45 to 65 percent of the silage material should remain on the middle sieve and 30 to 40 percent on the lower sieve of the separator. No more than 5 percent should be recovered in the bottom pan.

As corn silage makes up a greater proportion of the ration, more material should remain in the middle two sieves and less in the top sieve and bottom pan. The second layer of the Penn State Particle Separator is very important as the corn silage material on this screen is as important for good rumen function as the material on the top screen, yet this material is not sortable by the cow. Therefore in many cases the forage on the second sieve is even more critical than the top sieve for maintaining good rumen function.

Note that particle size recommendations are not related to the type of harvesting equipment. It is the end product, not how it got there, that is important. Newer systems for harvesting corn silage (chopping and rolling in one process) can create silage with a large percentage of long forage particles without large pieces of whole cobs or stalks. This forage can be excellent quality because it packs and ferments well in the silo. However, if the amount of long forage particles exceeds 3 to 8 percent, it is still sortable by the cow and will actually cause more rumen function problems due to uneven eating patterns of feeds. Typically, when conventional choppers are set to harvest corn silage at a long particle size, forage is predisposed to poor silo compaction and mold formation. The material usually has large pieces of cob, dry stalks, and leaves that allow a great deal of sorting and often may be refused by high producing cows. No matter what type of harvesting equipment that is used, the particle size recommendations are the same for the silage.

Improving Corn Silage Quality

Richard Lutz, Pioneer, A DuPont Company

Whole plant corn silage is one of the most valuable crops grown in dairy operations. At yields of 15 to 25 tons per acre, it can be worth $300 to $500 per acre. Dairy producers should always consider proven inputs to reduce storage loss and enhance animal performance.

Silage producers should initially have a firm handle on the management practices over which they can exert control. Proper attention should be paid to insure the corn silage is harvested at the proper maturity to maximize nutrient availability. Kernel processing should be considered to maximize starch and fiber digestibility of the crop for maximum crop yield and energy density. Then optimal silo filling management practices need to be followed to retain corn silage quality. Then, and only then, should a silage additive be considered. It is at this point that "good" silages can potentially be made "better" through the proper use of a research-proven silage inoculant.

Dairy producers are becoming increasingly aware of the fermentative and animal productivity reasons for considering the use of a silage inoculant. The positive effects of silage inoculants observed in controlled industry and university studies have been: 1) lower pH, 2) greater content of lactic acid, 3) greater dry matter recovery, 4) improved digestibility, 5) animal performance (milk production), and 6) improved stability (bunklife) of the ensiled material when it is exposed to air.

Studies completed by Richard Muck at the U.S. Dairy Forage Research Center in Madison, Wis., demonstrate inoculants tend to improve animal performance 3 to 5 % over untreated feed. Muck's studies indicate dairy cows fed corn silage with inoculants can produce 2 to 3 pounds more milk per day than those fed untreated silage.


John Landis of Lancaster County understands the value of feeding inoculated silage in his herd.

In Pioneer research, a corn silage specific inoculant has demonstrated 5.6% improved NDFD (neutral detergent fiber digestibility) over untreated corn silage. This NDFD difference equates to 3.1 lbs. more milk per cow per day compared to untreated silage. This calculation is based on research from Mike Allen, at Michigan State University, whose studies indicate that every additional one percentage point increase in NDFD translates into .55 lbs. more milk per cow per day.

Recently, there has been considerable interest in utilizing specific corn silage *Lactobacillus plantarum* and *Lactobacillus buchneri* bacterium strains to enhance fermentation, aerobic stability and improve animal performance. This type of combination product improves the ratio of lactic acid to acetic acid, which reduces the growth of harmful yeasts and molds. This in turn improves aerobic stability to keep silage fresher and cooler both in storage and in the feed bunk.

Since milk prices have improved considerably since last season, producers should consider investing in a research proven silage inoculant in an effort to enhance the nutritional value of this year's corn silage crop.

Where trade names appear, no discrimination is intended and no endorsement by Penn State Cooperative Extension is implied.

"Quotable Quotes"

"Human beings, by changing the inner attitudes of their minds, can change the outer aspects of their lives."
— *William James, American Psychologist, Professor, Author; 1842-1910.*

"The whole problem with the world is that fools and fanatics are always so certain of themselves, but wiser people so full of doubts."
— *Bertrand Russell, British Philosopher, Mathematician, Essayist; 1872-1970.*

"We must believe in ourselves or no one else will believe in us; we must match our aspirations with the competence, courage, and determination to succeed."
— *Rosalyn Yalow, 1977 Noble Prize winning medical physicist; 1921 -*

Managing Bunker Silos

Paul H. Craig, Penn State Capital Region Forage Agronomist

In recent years corn hybrid breeders have developed some outstanding hybrids for corn silage production. Not too long ago the recommendation for corn silage production was to select the highest grain yielding hybrids and then harvest at optimum whole plant moisture content. Recent selections are now made based on grain yield, type and digestibility and increasing the digestibility of stover. Significant differences exist between hybrids and most silage feeders are now basing their hybrid selection on multiple factors.

However, even the best silage hybrids planted at optimum populations with excellent weed control and fertility management can result in less than optimum feed value if harvest and storage conditions are not managed properly. Across the United States there is work being done at Universities to measure and monitor silage storage systems to determine what effects management can have on silage quality.

Investigations at Wisconsin have shown that the two greatest factors affecting bunker silage densities are the delivery rate of the forage to the bunker and the size of the tractor(s) doing the packing. With custom harvesting, especially corn silages, the delivery rate can easily exceed 100 tons per hour. At this rate a very heavy packing tractor is needed to provide sufficient compaction. Unfortunately many dairy farmers hiring custom harvesters do not have access to such large equipment and the chopper gets ahead of the packing operation and a poor pack job results. Rental of large heavy tractors for packing would be an option for smaller dairies that use a custom harvester.

A tight pack, of any silage crop, sets the stage for rapid reductions of oxygen levels. In a bunker silo the denser the pile is packed the better the quality of feed. Research at Wisconsin and Cornell Universities indicates that bunker silo managers should set a dry matter density goal of 14 lbs. of dry matter per cubic foot for their bunker silage in order to minimize spoilage potential. Densities greater than 14 can be attained with proper considerations at packing time.

Capital Region Bunker Density Study

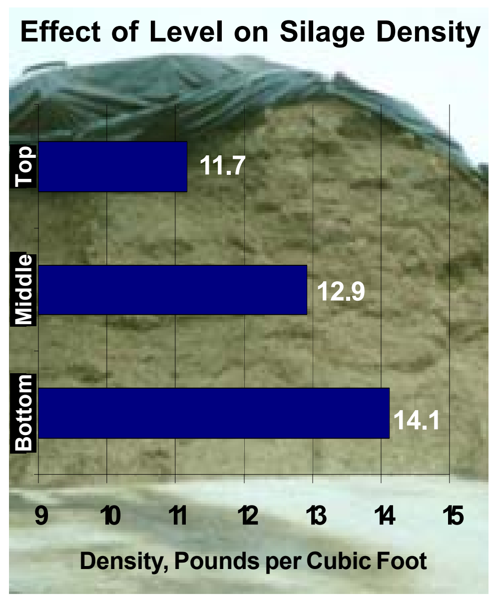
In February, March and April of 2004 twenty-two bunker silos were measured for dry matter densities. Drs. Greg Roth and Dennis Buckmaster, PSU Crop and Soil Sciences and Ag and Biological Engineering Departments and Paul H. Craig, Regional Forage Crop Extension Educator conducted a survey of bunker silos. In total 272 density samples were taken. A Stihl gas operated drill and a 2 inch diameter core sample was used to drill into the face of each bunker at 12 locations and densities calculated based on volume, forage mass and dry matter content.

The 12 sampling points were taken at 3 levels across the entire face of the bunker. The lowest level was approximately 3 feet above the floor, the top level was approximately 3 feet below the surface unless significant spoilage was noted and then the probe was lowered accordingly, and in the middle of the pile. Each level was sampled at 4 locations, numbered 1 to 4, from left to right facing the pile.

Results

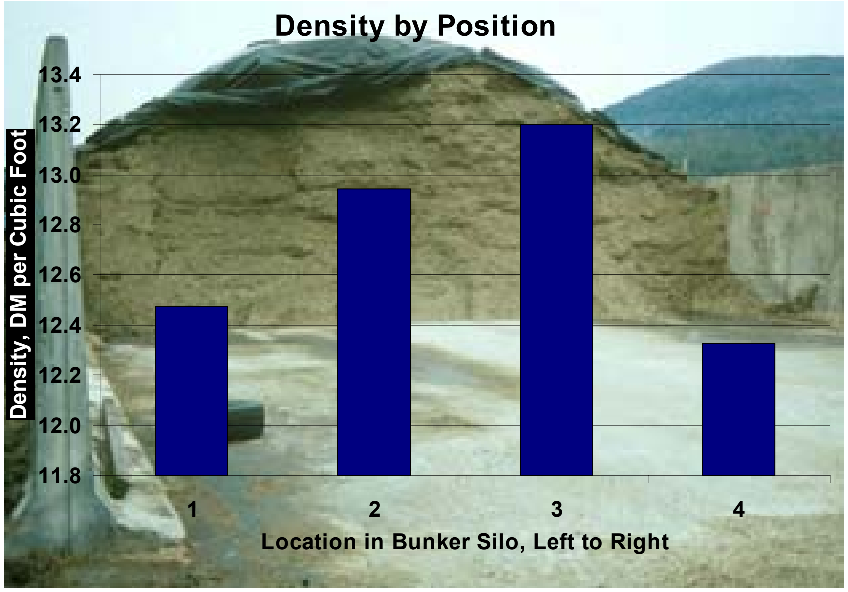
Dry matter densities of the 272 samples ranged from 6.8 to 19.8 lbs DM/ft^3.The twelve points were then averaged for each silo. These average densities ranged from 8.3 to 16.4 DM/ft^3. Of the twenty-two bunkers sampled, 7 averaged greater than the target of 14 DM/ft^3 and 8 averaged less than 12 DM/ft^3. This would indicate that many operators have a good packing system in use and that there is significant room for improvement.

Taking a closer look at an individual bunker and the 12 sampling points some interesting trends became evident. First it was obvious that the bottom level consistently had the highest densities, followed by the middle level and then the top. This affect is commonly referred to as self packing. The trend also shows that too frequently the bottom and the middle of the bunkers were of excellent densities but that the top level density was too low.



One farm, with 8 foot sidewalls filled to nearly 14 feet at the highest point had densities, by level: bottom – 16.1; middle – 14.8 and the top – 11.3 DM/ft^3. This would indicate that greater detail to the final packing procedure would be beneficial.

In addition to a difference in densities found by the level of the pile there was also a significant difference in densities in the bunker position. Positions, at each level, were noted as 1, 2, 3, 4 from the left to the right. The density trend in each level was that densities were the lowest on the outside and higher on the inside.



This indicates that the packing along the outside walls is not the same as the core. This is probably due to the inability to run the tractor wheels along the edges of the walls. This becomes more evident on the same bunker as noted earlier that was over filled. Here the densities ranged from 13.1, 13.8, 14.1 and 12.6 from left to right.

So what were the producers who had the highest packing densities doing to achieve this goal?

First, all of these top producers used the progressive wedge method to fill the trench. In this process wagons or trucks are dumped at the front of the pile and then using a blade the forage is pushed up a sloping face creating a wedge that progresses from the rear of the bunker to the front. This results in far less surface area exposure during the filling process. Most producers commented that they would cover the pile daily with plastic.

Top packers also attempted to manage the speed of harvest and the delivery rate of silage to the bunker so that packing equipment could work with thinner layers of silage. Packing a thinner layer produced a tighter pack. Six inches maximum is preferred. Too often, at higher harvest rates, layers would exceed 12 inches. On many farms it was the manager who did the packing and he would be in constant contact with the harvester to set the pace. The extra cost of a slightly slower harvest more than paid for itself in silage quality.

Very heavy tractors were used to push and pack. Tractors in excess of 40,000 pounds were used. Extra weight was added wherever possible including wheel weights, tire fluids, front-end weights and even 3000 pound concrete blocks mounted on the rear of tractors. If needed a second or even a third heavy packing tractor was incorporated.

Dual wheels were preferred for the extra weight and stability. The larger "footprint" of dual wheels provides less surface compaction of the forage compared to a single wheeled tractor of the same weight. However, heavy axle loads result in greater compaction lower into the forage mass. This affect is reflected in the lower densities found in the top level of all silos. Dual wheeled tractors are excellent packing machines for the middle and lower levels but a smaller footprint, single wheeled tractor of same weight, on the top ¼ of the pile would be preferred. Greater packing time on the surface will result in higher densities to finish off the pile. Rollover protection is important, including roll bars and a seatbelt. All bunk managers noted the importance of an experienced tractor operator to improve safety during packing.

What others have found.

Dr. Brian Holmes, University of Wisconsin Ag Engineer has investigated bunker silo densities. He has developed an Excel spreadsheet to predict bunker densities based on crop moistures, delivery rate, packing tractor(s) weight, layer thickness, and packing time. Producers enter their own values and estimate what their densities would be. It is then possible to see what affect using a heavier tractor or slowing the delivery rate or a thinner packing layer would have on final densities. The free, downloadable program is available at http://www.uwex.edu/ces/crops/uwforages/h&s-fp.htm

As the 2004 silage harvest season nears it would be beneficial to review harvesting and packing procedures. Growing the most digestible, highest yielding corn silage crop is of limited value when storage and feeding practices significantly reduce the amount of milk or beef produced. Ensuring the best available feed is put into the bunk, packing to maintain this quality and then managing proper feed out sets the stage for the entire feeding program until the next harvest season.

"Management Tip"

This regular feature is focused on helping improve management practices of dairy managers.

"You Are Not Smarter Than Everybody."

You may be smarter than anyone, but you are not smarter than everyone. Seek input from the group, and LISTEN to it. You will be surprized at what you can learn.

Using Plastic on Sidewalls

Paul Craig, Penn State Capital Region Forage Agronomist

An interesting observation on many dairies this spring was the increasing use of plastic on the sidewalls of bunkers. Before the pile is started plastic is hung over the sidewalls. In many cases this was leftover plastic from the previous season. Usually the plastic was only wide enough to cover the wall edge of the pile and was then tucked underneath the surface layer of plastic. This plastic is believed to do two important things. First, concrete does not exclude air and joints or cracks in walls can allow air to reach silage that is typically less dense on the edges and allows greater dry matter losses. In addition, sidewall plastic significantly reduces the amount of rain and snow water that collects at wall edges. This unwanted moisture leaches out organic acids in the silage raises silage pH levels and adds oxygen into the pile. The result is an ideal environment for the growth and development of molds and fungus.

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